Sinusoidal Steady State

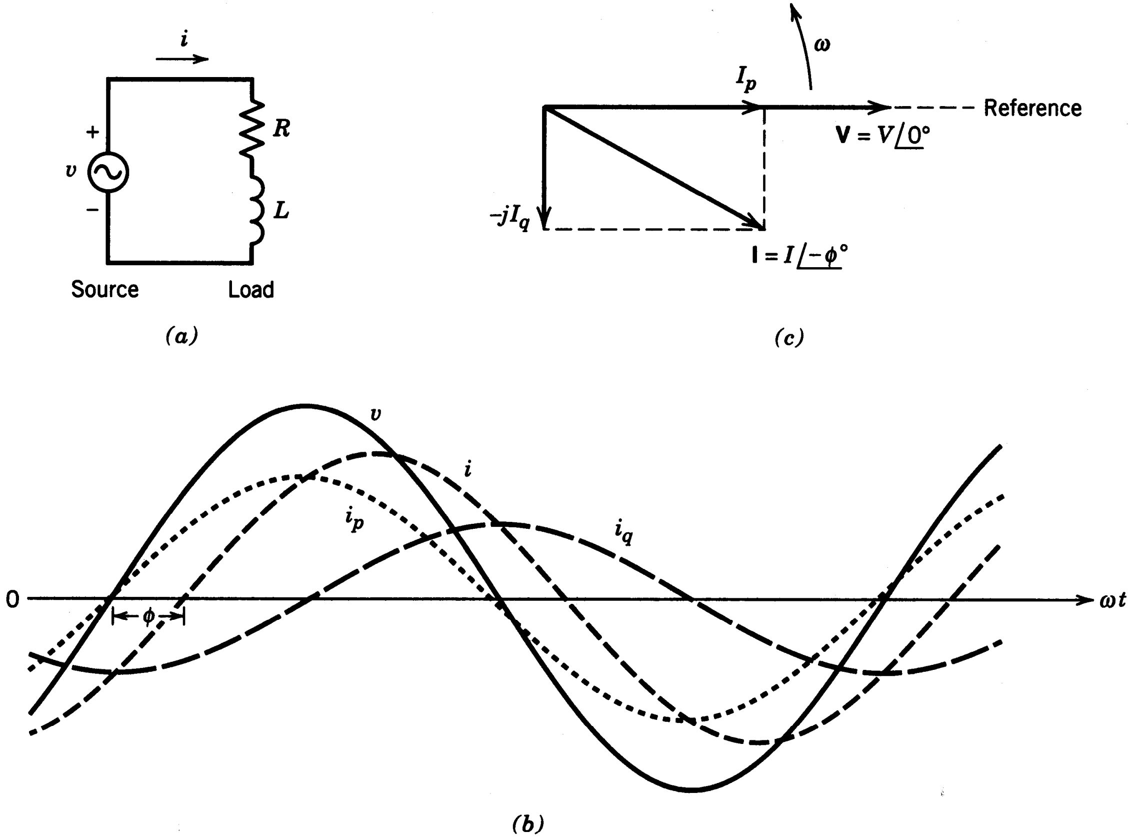


Figure 3-2 Sinusoidal steady state.

Three-Phase Circuit

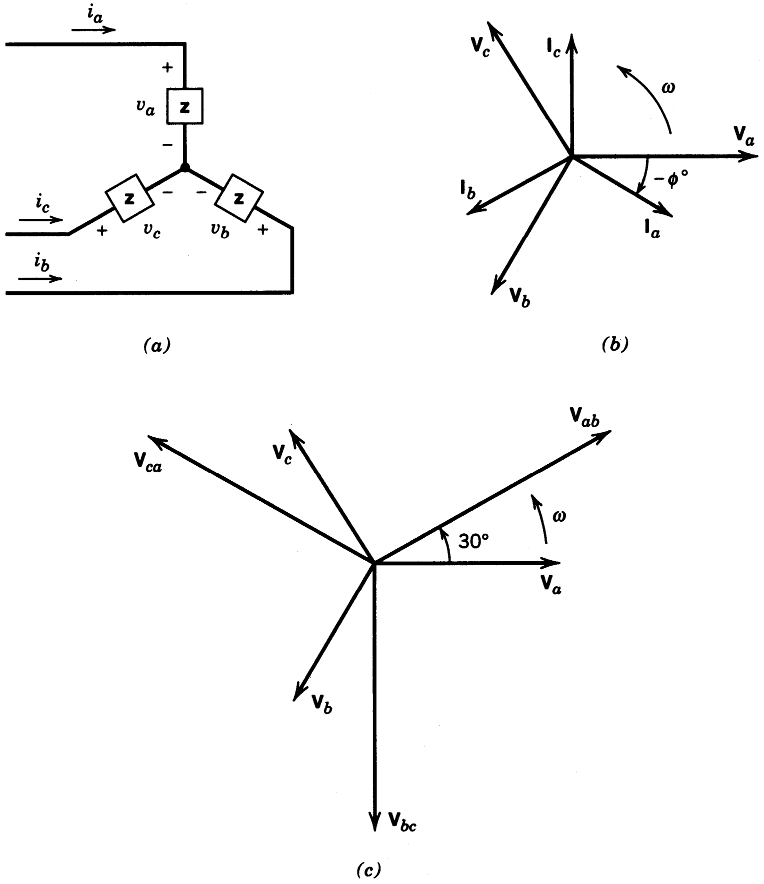


Figure 3-3 Three-phase circuit.

Diode Rectifier

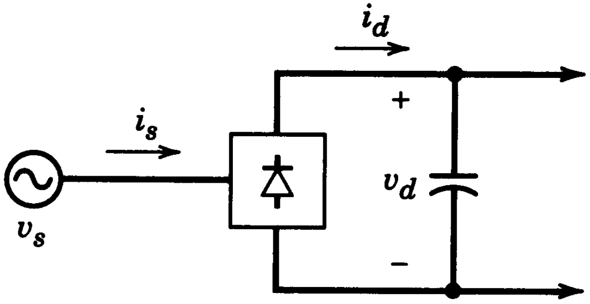
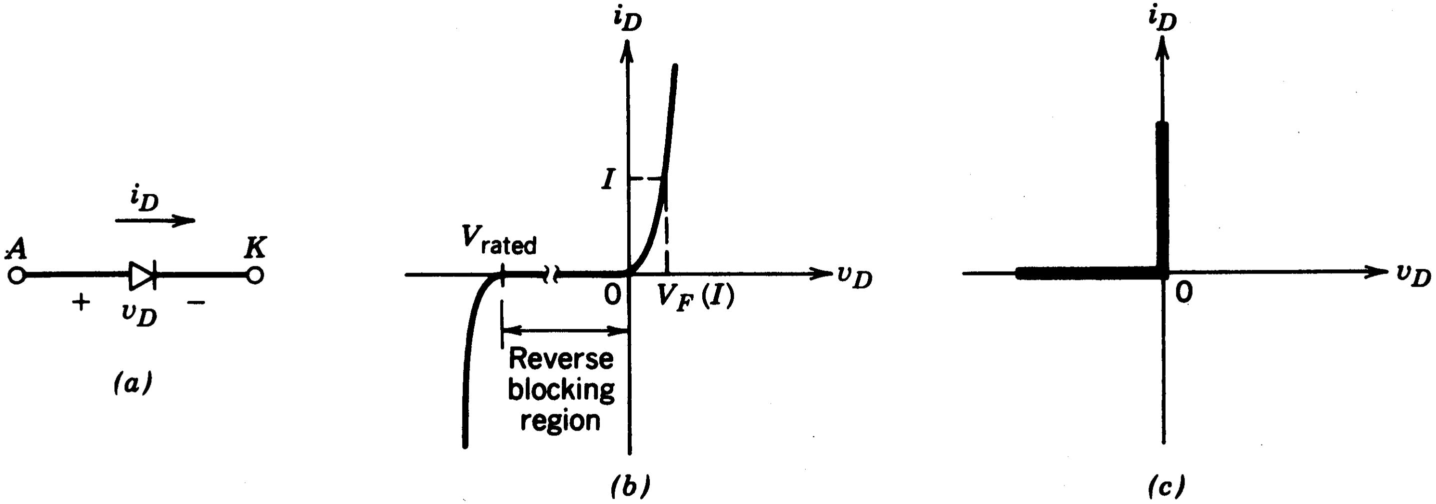


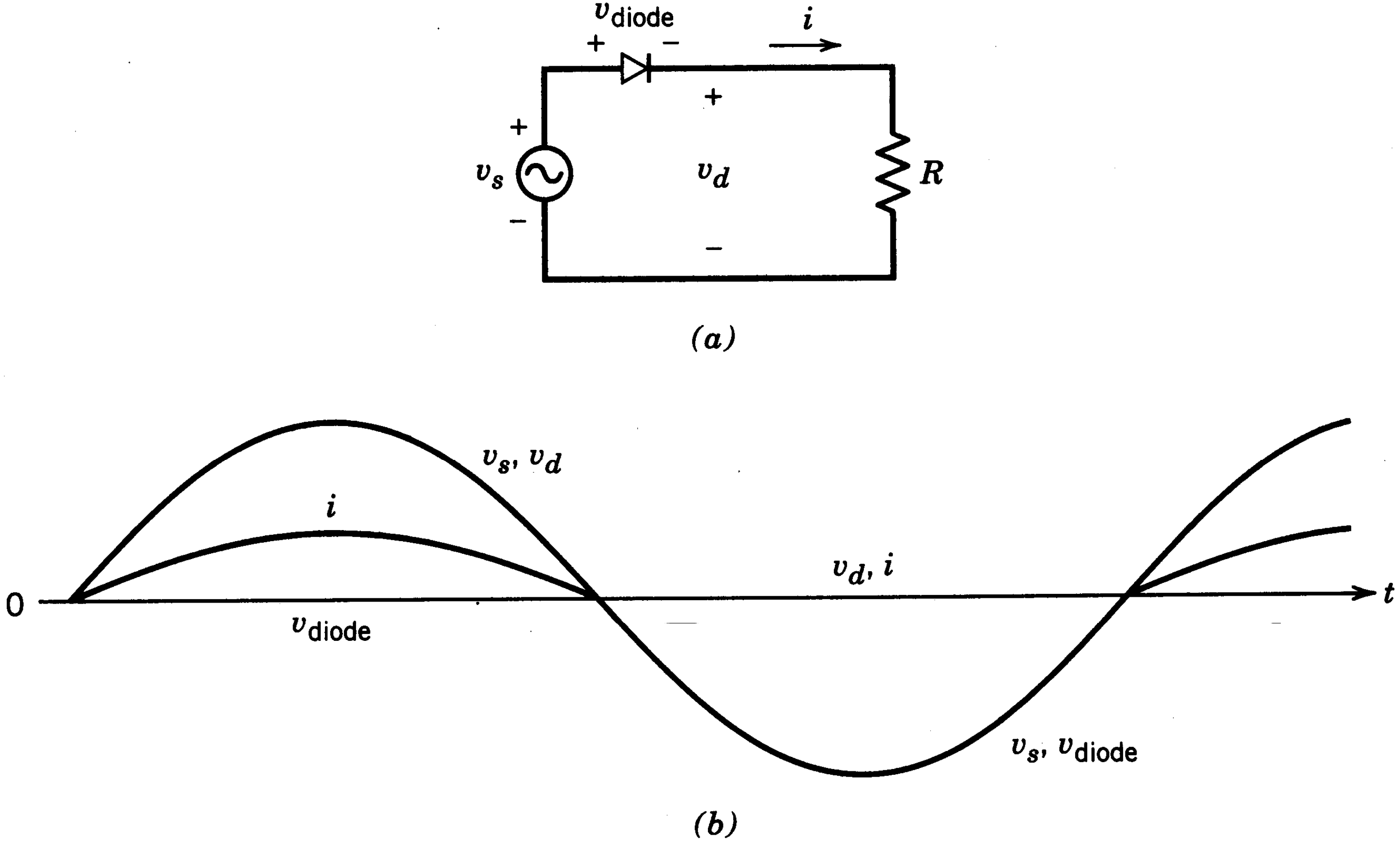
Figure 5-1 Block diagram of a rectifier.



(a) (b) (c)

Figure 2-1 Diode: (*a*) symbol, (*b*) *i–v* characteristic, (*c*) idealized characteristic.

A Simple Circuit



(a)

(b)

Figure 5-2 Basic rectifier with a load resistance.

- Resistive load

A Simple Circuit (*R-L* Load)

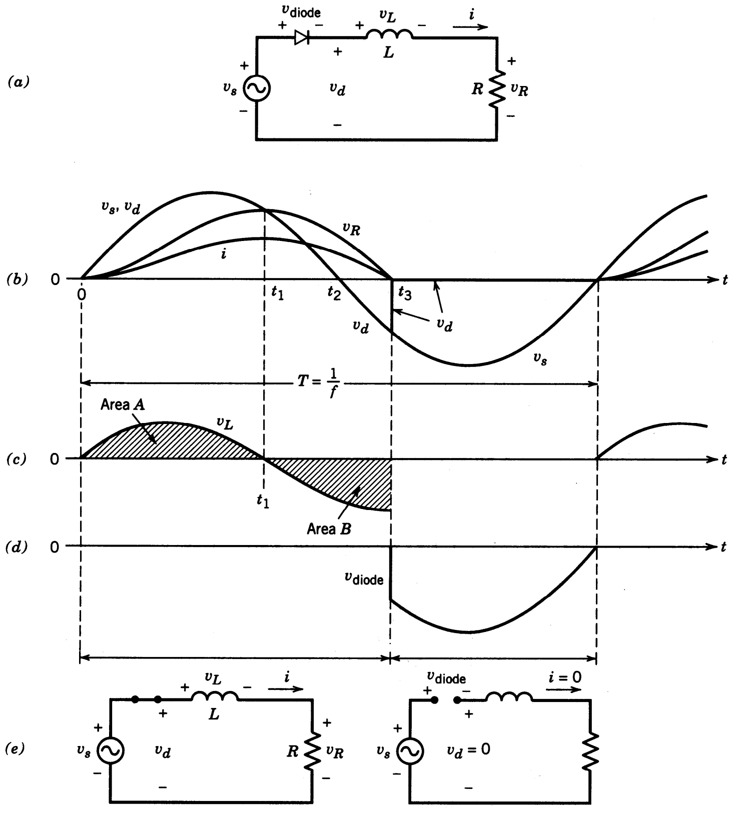


Figure 5-3 Basic rectifier with an inductive load.

- The current continues to flow for a while even after the input voltage has gone negative

A Simple Circuit (Load has a dc back-emf)

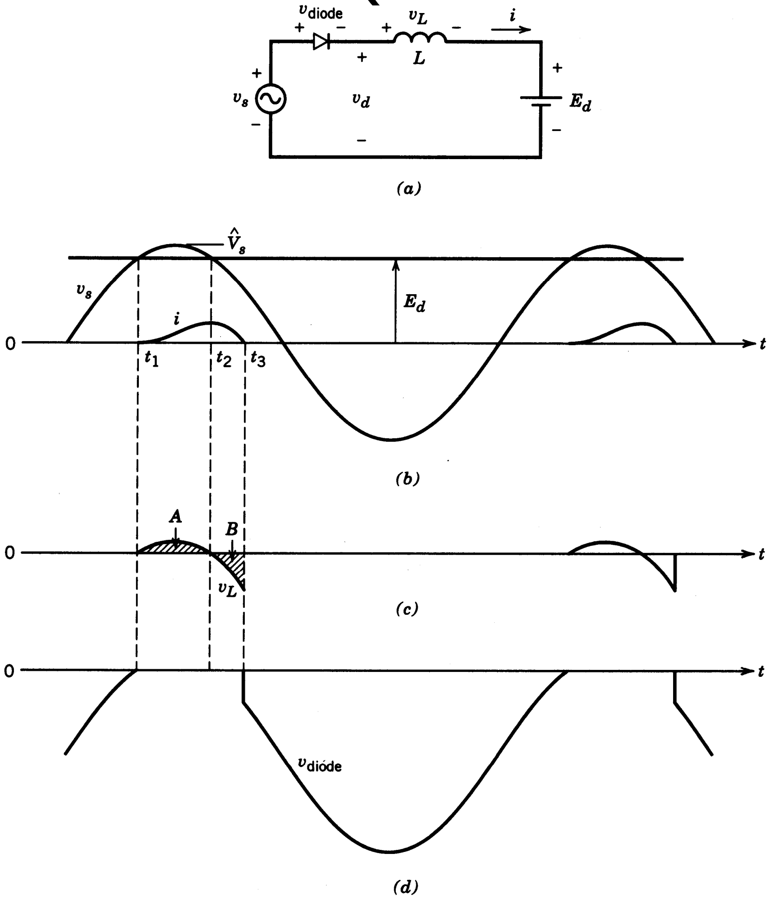


Figure 5-4 Basic rectifier with an internal dc voltage.

- Current begins to flow when the input voltage exceeds the dc back-emf

- Current continues to flows for a while even after the input voltage has gone below the dc back-emf

Single-Phase Diode Rectifier Bridge

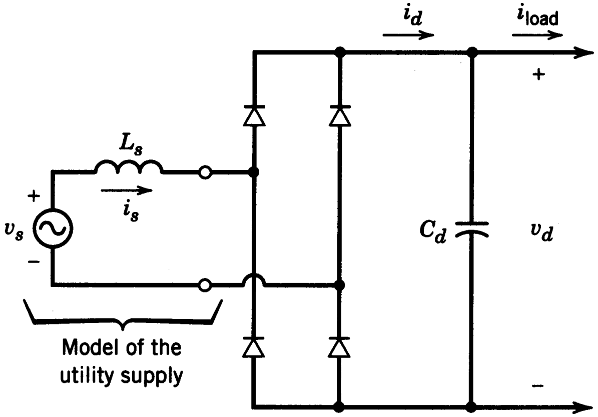


Figure 5-5 Single-phase diode bridge rectifier.

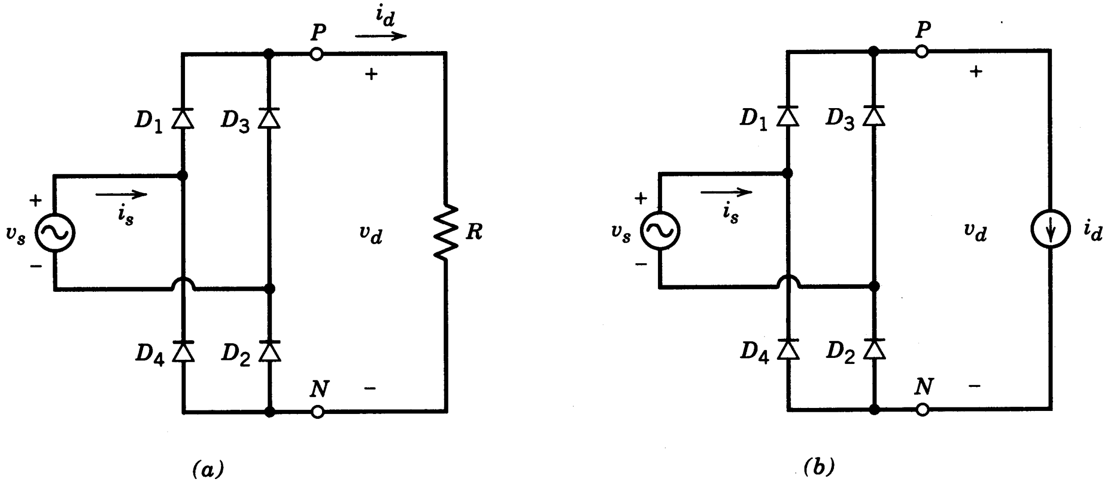


Figure 5-6 Idealized diode bridge rectifiers with $L_s = 0$.

Redrawing Diode-Rectifier Bridge

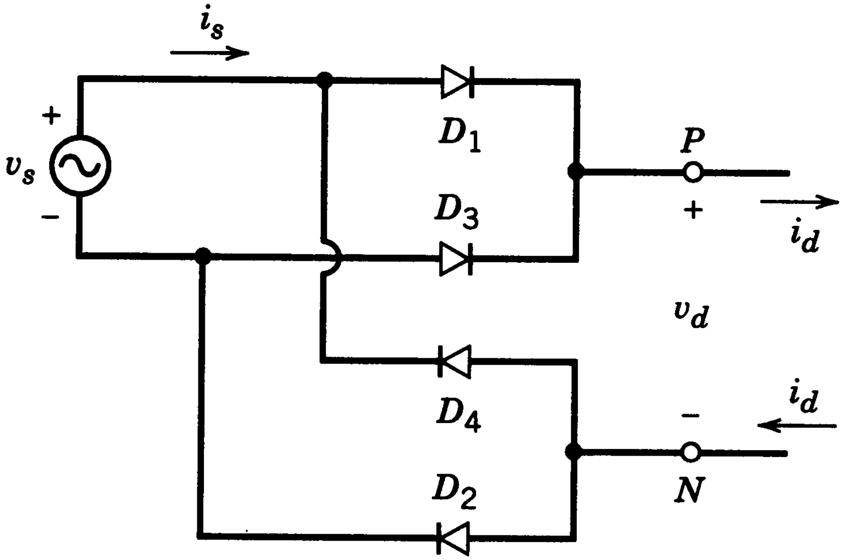


Figure 5-7 Redrawn rectifiers of Fig. 5-6.

- Two groups, each with two diodes

Waveforms with a purely resistive load and a pure direct current at the output

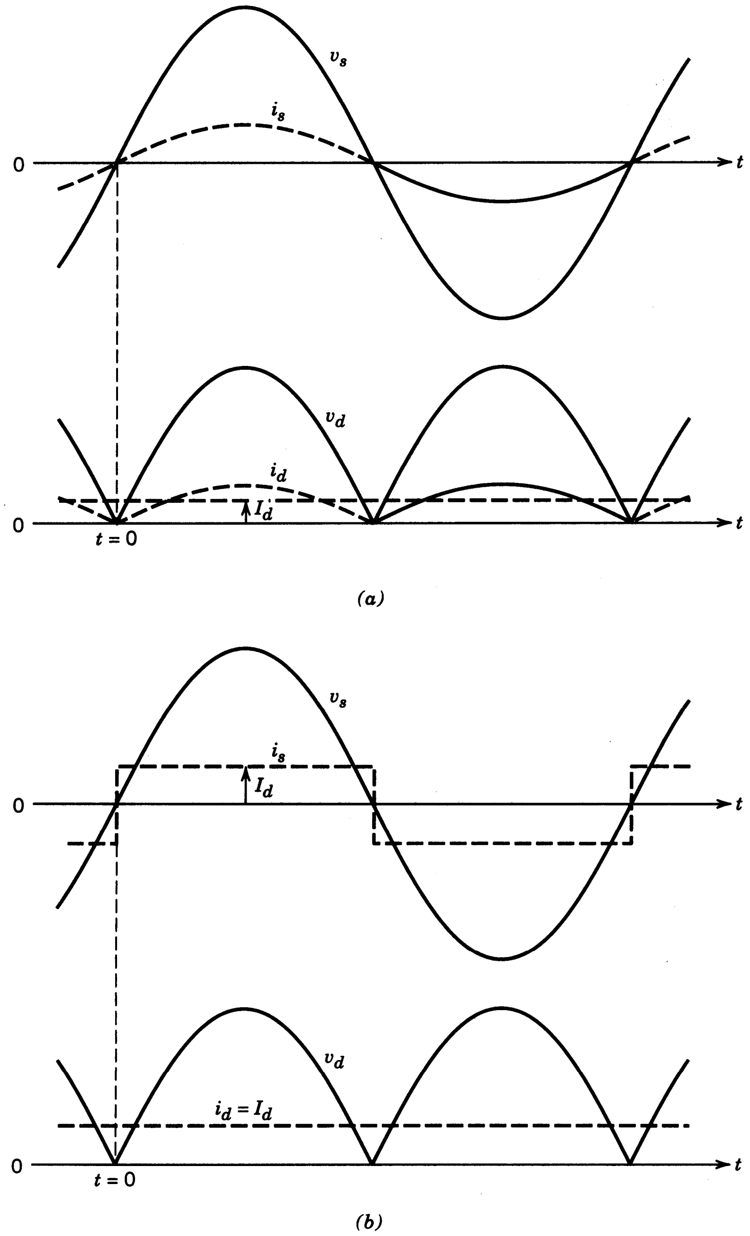


Figure 5-8 Waveforms in the rectifiers of (*a*) Fig. 5-6*a* and (*b*) Fig. 5-6*b*.

- In both cases, the dc-side voltage waveform is the same

Fourier Analysis

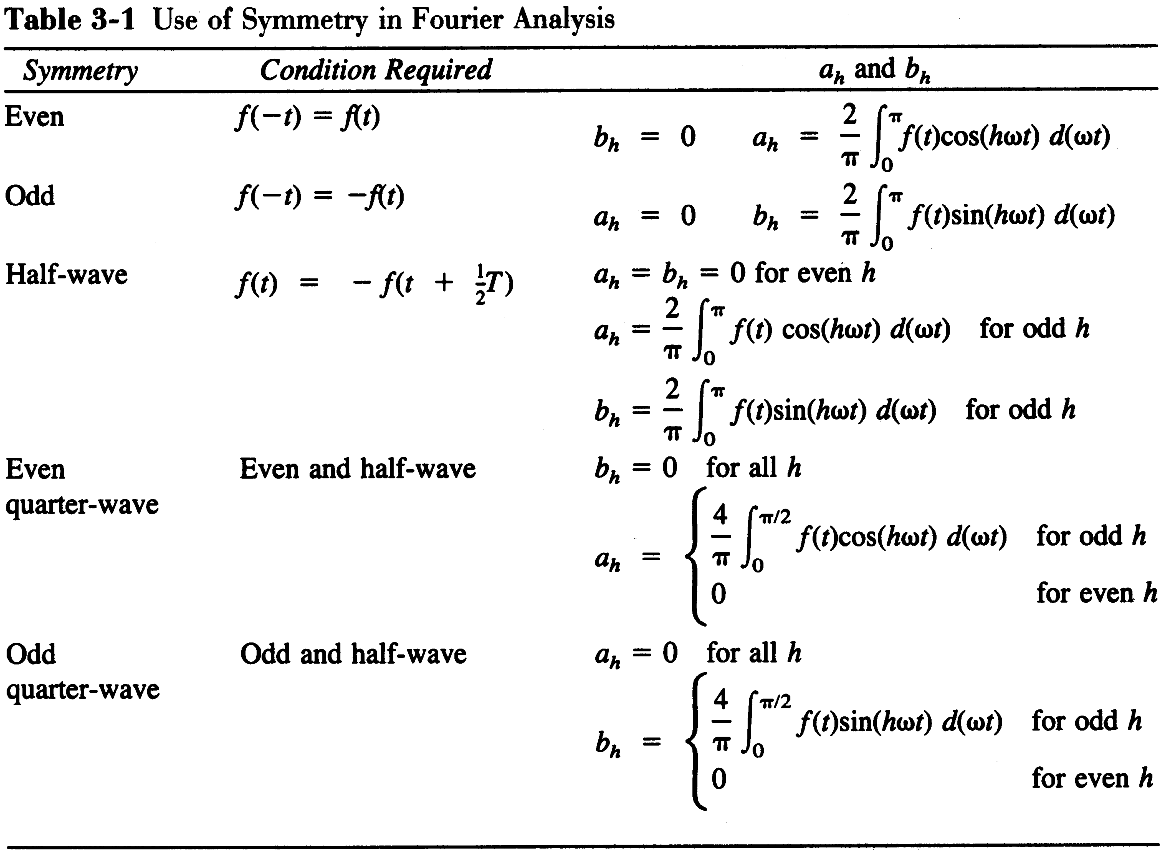
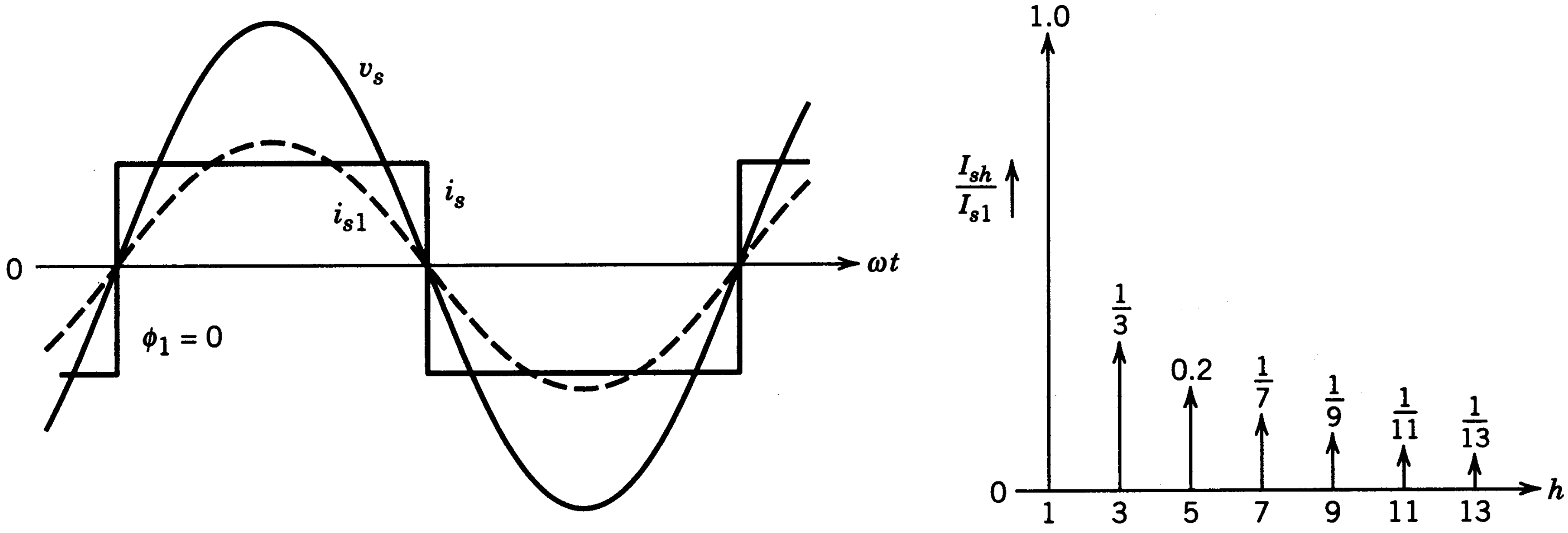


Table 3-1 Use of Symmetry in Fourier Analysis

Symmetry	*Condition Required*	a_h and b_h
Even	$f(-t) = f(t)$	$b_h = 0 \qquad a_h = \frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\,d(\omega t)$
Odd	$f(-t) = -f(t)$	$a_h = 0 \qquad b_h = \frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\,d(\omega t)$
Half-wave	$f(t) = -f(t + \frac{1}{2}T)$	$a_h = b_h = 0$ for even h $a_h = \frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\,d(\omega t)$ for odd h $b_h = \frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\,d(\omega t)$ for odd h
Even quarter-wave	Even and half-wave	$b_h = 0$ for all h $a_h = \begin{cases} \frac{4}{\pi}\int_0^{\pi/2} f(t)\cos(h\omega t)\,d(\omega t) & \text{for odd } h \\ 0 & \text{for even } h \end{cases}$
Odd quarter-wave	Odd and half-wave	$a_h = 0$ for all h $b_h = \begin{cases} \frac{4}{\pi}\int_0^{\pi/2} f(t)\sin(h\omega t)\,d(\omega t) & \text{for odd } h \\ 0 & \text{for even } h \end{cases}$

Diode-Rectifier Bridge Input Current



(a) *(b)*

Figure 5-9 Line current i_s in the idealized case.

- Idealized case with a purely dc output current

Diode-Rectifier Bridge Analysis with AC-Side Inductance

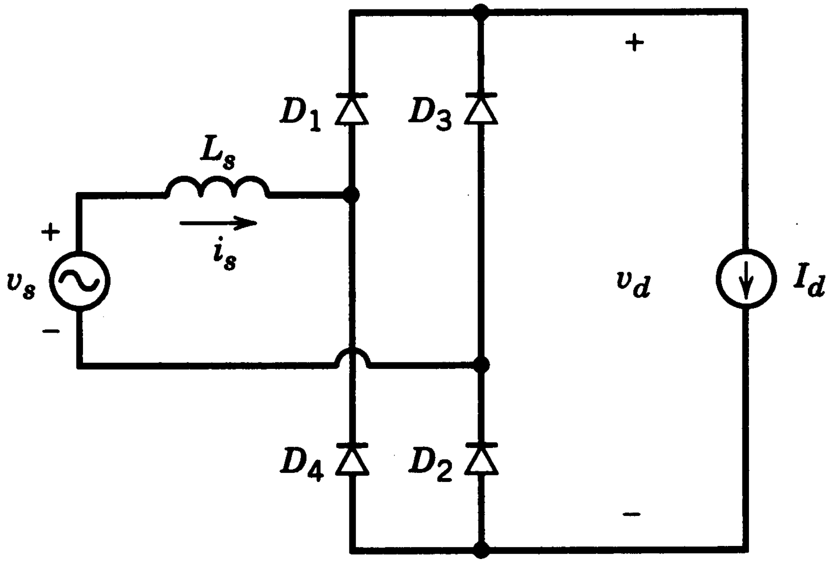
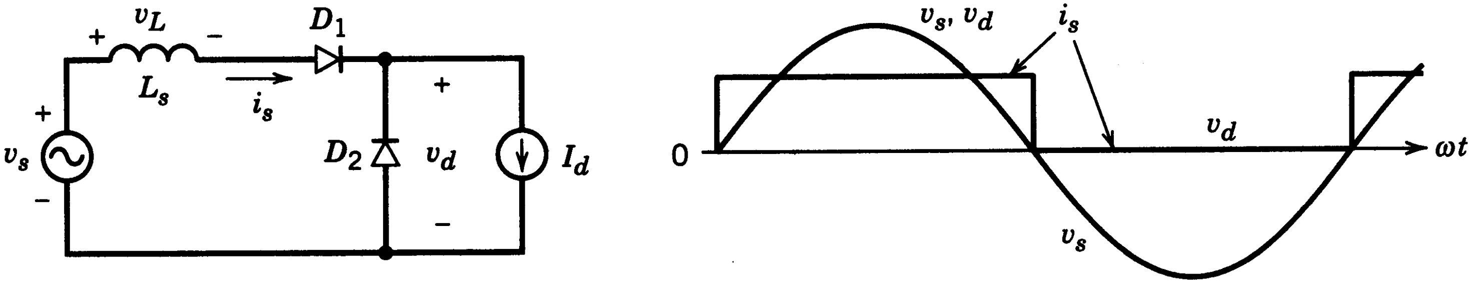


Figure 5-10 Single-phase rectifier with L_s.

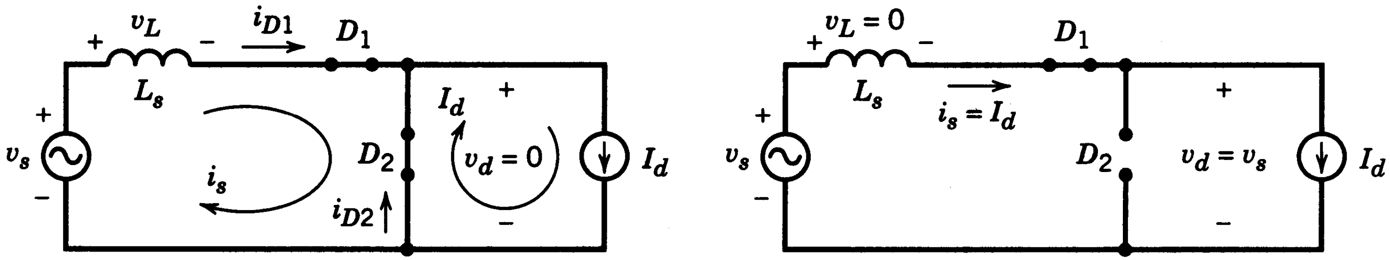
- Output current is assumed to be purely dc

Understanding Current Commutation



(a) (b)

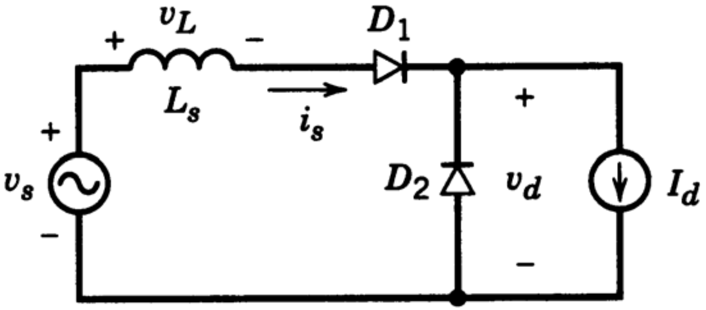
Figure 5-11 Basic circuit to illustrate current commutation. Waveforms assume $L_s = 0$.



(a) (b)

Figure 5-12 (a) Circuit during the commutation. (b) Circuit after the current commutation is completed.

Current Commutation Waveforms



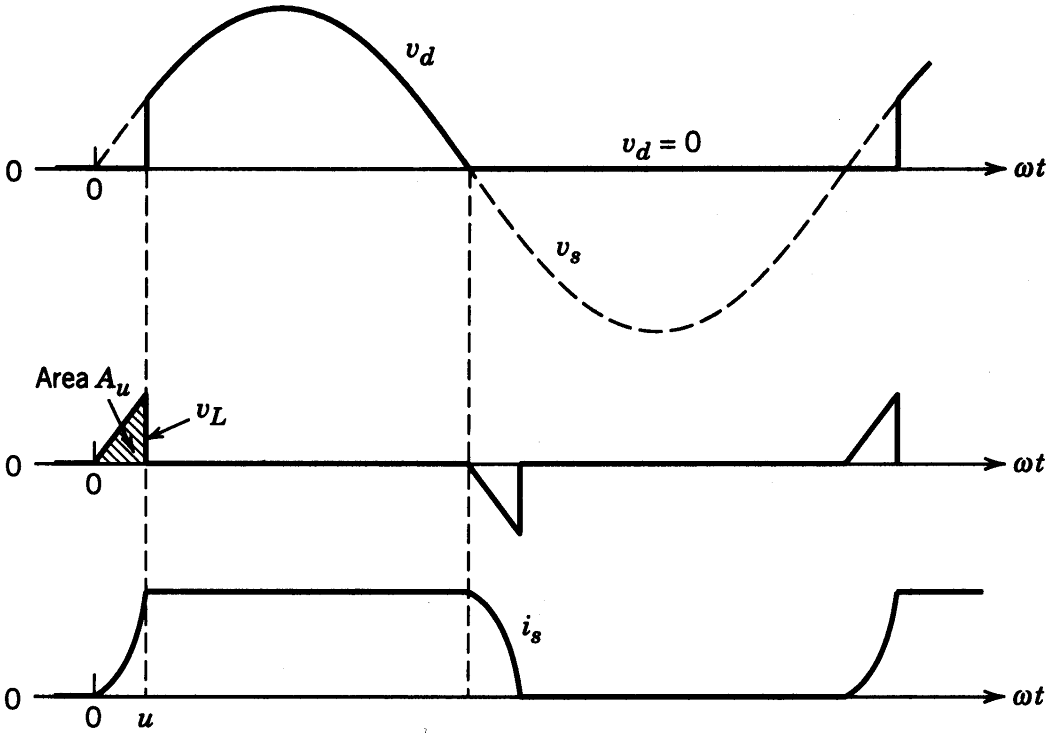


Figure 5-13 Waveforms in the basic circuit of Fig. 5-11. Note that a large value of L_s is used to clearly show the commutation interval.

- Shows the volt-seconds needed to commutate current

Current Commutation in Full-Bridge Rectifier

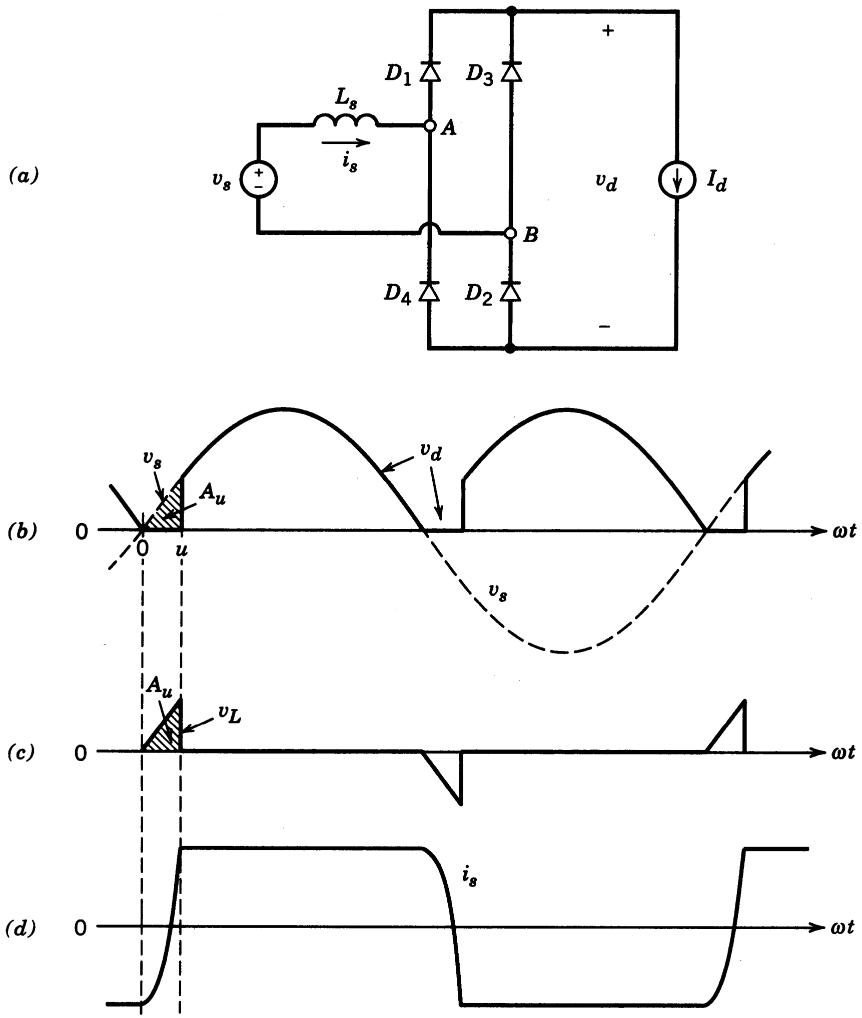


Figure 5-14 (*a*) Single-phase diode rectifier with L_s. (*b*) Waveforms.

- Shows the necessary volt-seconds